



The role of multislice computed tomography in the diagnosis of coronary artery fistulas

Koroner arter fistüllerinin tanısında çok kesitli bilgisayarlı tomografinin yeri

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ABSTRACT

Background: This study aims to investigate the frequency and the anatomical features of coronary artery fistulas in patients undergoing multislice computed tomographic angiography for various reasons.

Methods: Between January 2009 and July 2015, a total of 40 coronary artery fistulas of 26 patients were retrospectively analyzed using multislice computed tomographic angiography in our clinic. The affected arteries and localizations of the fistulas were evaluated.

Results: Of the fistulas, 11 (27.5%) were originating from the circumflex artery, 10 (25%) from the left anterior descending artery, four (10%) from the diagonal arteries, three (7.5%) from the left main coronary artery, three (7.5%) from the right main coronary artery, three (7.5%) from the septal artery, three (7.5%) from the conus artery, one (2.5%) from the obtuse marginal artery, one (2.5%) from left anterior descending artery proper (dual LAD), and one (2.5%) from the ramus intermedius. One of the conus arteries was directly originating from the right coronary sinus. Twelve (30%) of the fistulas were draining into the pulmonary trunk, eight (20%) into the left ventricle, seven (17.5%) into the right ventricle, five (12.5%) into the superior vena cava, three (7.5%) into the right main pulmonary artery, two (5%) into the right atrium, one (2.5%) into the left atrium, one (2.5%) into the right internal thoracic artery, and one (2.5%) into the sinus coronarius.

Conclusion: Compared to conventional angiography, multislice computed tomographic angiography is a non-invasive modality which allows enhancing coronary artery fistulas at a higher rate and visualizing the cardiac anatomy in detail.

Keywords: Coronary artery; fistula; multislice computed tomographic angiography.

ÖZ

Amaç: Bu çalışmada çeşitli nedenlerle çok kesitli bilgisayarlı tomografik anjiyografi incelemesi yapılan hastalarda koroner arter fistüllerinin sıklığı ile anatomik özellikleri araştırıldı.

Çalışma planı: Ocak 2009 - Temmuz 2015 tarihleri arasında kliniğimizde çok kesitli bilgisayarlı tomografik anjiyografi kullanılarak 26 hastada toplam 40 adet koroner arter fistülü retrospektif olarak incelendi. Etkilenen arterler ve fistüllerin yerleşim yerleri değerlendirildi.

Bulgular: Fistüllerin 11'i (%27.5) sirkümfleks arterden, 10'u (%25) sol ön inen arterden, dördü (%10) diagonal arterden, üçü (%7.5) sol ana koroner arterden, üçü (%7.5) sağ ana koroner arterden, üçü (%7.5) septal arterden, üçü (%7.5) konus arterinden, biri (%2.5) obtus marjinal arterden, biri (%2.5) sol ön inen arter properden (dual LAD) ve biri (%2.5) ramus intermedius köken almaktaydı. Konus arterlerinden biri doğrudan sağ koroner sinüsten köken almaktaydı. Fistüllerden 12'si (%30) pulmoner trunkusa, sekizi (%20) sol ventriküle, yedisi (%17.5) sağ ventriküle, beşi (%12.5) superior vena kavaya, üçü (%7.5) sağ ana pulmoner artere, ikisi (%5) sağ atriyum, biri (%2.5) sol atriyum, biri (%2.5) sağ internal torasik artere ve biri de (%2.5) sinüs koronarius açılmaktaydı.

Sonuç: Konvansiyonel anjiyografiye kıyasla, çok kesitli bilgisayarlı tomografi anjiyografi koroner arter fistüllerinin daha yüksek oranda tespit edilebilmesine ve kalp anatomisinin ayrıntılı bir şekilde görüntülenebilmesine olanak sağlayan invaziv olmayan bir yöntemdir.

Anahtar sözcükler: Koroner arter; fistül; çok kesitli bilgisayarlı tomografik anjiyografi

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Coronary artery fistulas (CAF) are defined as the connection between a coronary artery and any heart chamber, large vessels or other vascular structures. The coronary artery fistula was first described in 1865 by Krause.^[1] Majority of the cases are congenital, although they may also occur iatrogenically. Acquired CAFs have rarely been reported.^[2] Blood bypasses the myocardial capillaries bed directly into the heart chamber, the major mediastinal vascular structure or another vessel. These abnormalities are the result of the non-closure of the normally present intratrabecular vacuoles/sinusoids during the intrauterine period. It has been reported to have an incidence of 0.2-0.4% among all congenital heart diseases.^[3] Its incidence in the general population is suggested to be around 0.002%. On the other hand, its incidence rate among patients who have undergone coronary angiography was found to be 0.05-0.25%.^[4-7]

In this study, we aimed to reveal the incidence rate and anatomical features of CAF in patients who were subjected to multislice computed tomographic angiography (MCTA) in our hospital for various reasons.

PATIENTS AND METHODS

In our clinic, reports of the 2.415 MCTA examination performed between 01.01.2009 and 08.07.2015 were

retrospectively reviewed from the hospital automation system. Twenty - six patients who were diagnosed with coronary artery fistula were included in the study. The medical histories of the patients were examined using their files. The vascular association and localizations of the fistulas were evaluated. The study protocol was approved by the Ethics Committee of the University of Health Sciences Siyami Ersek Thoracic and Cardiovascular Surgery Training and Research Hospital. The study was conducted in accordance with the Declaration of Helsinki.

RESULTS

Thirteen (50%) of the patients diagnosed with fistula were males while 13 (50%) were females. The age range of the patients was 16-71 and the mean was 51.4 ± 13.6 .

A total of 40 coronary fistulas were detected, one in 19 patients, two in two patients, three in three patients and four in two patients. Of the fistulas, 11 (27.5%) originated from the circumflex artery, 10 (25%) from the left anterior descending (LAD) artery, four (10%) from the diagonal arteries, three (7.5%) from the left main coronary artery (LMCA), three (7.5%) from the right main coronary artery (RCA), three (7.5%) from the septal artery, three (7.5%) from the conus artery, one (2.5%) from the obtuse marginal (OM) artery, one



Figure 1. (a) Three dimensional volume rendered, (b) curved maximum intensity projection images of fistula originating from the right anterior descending artery proper and draining into the pulmonary trunk.

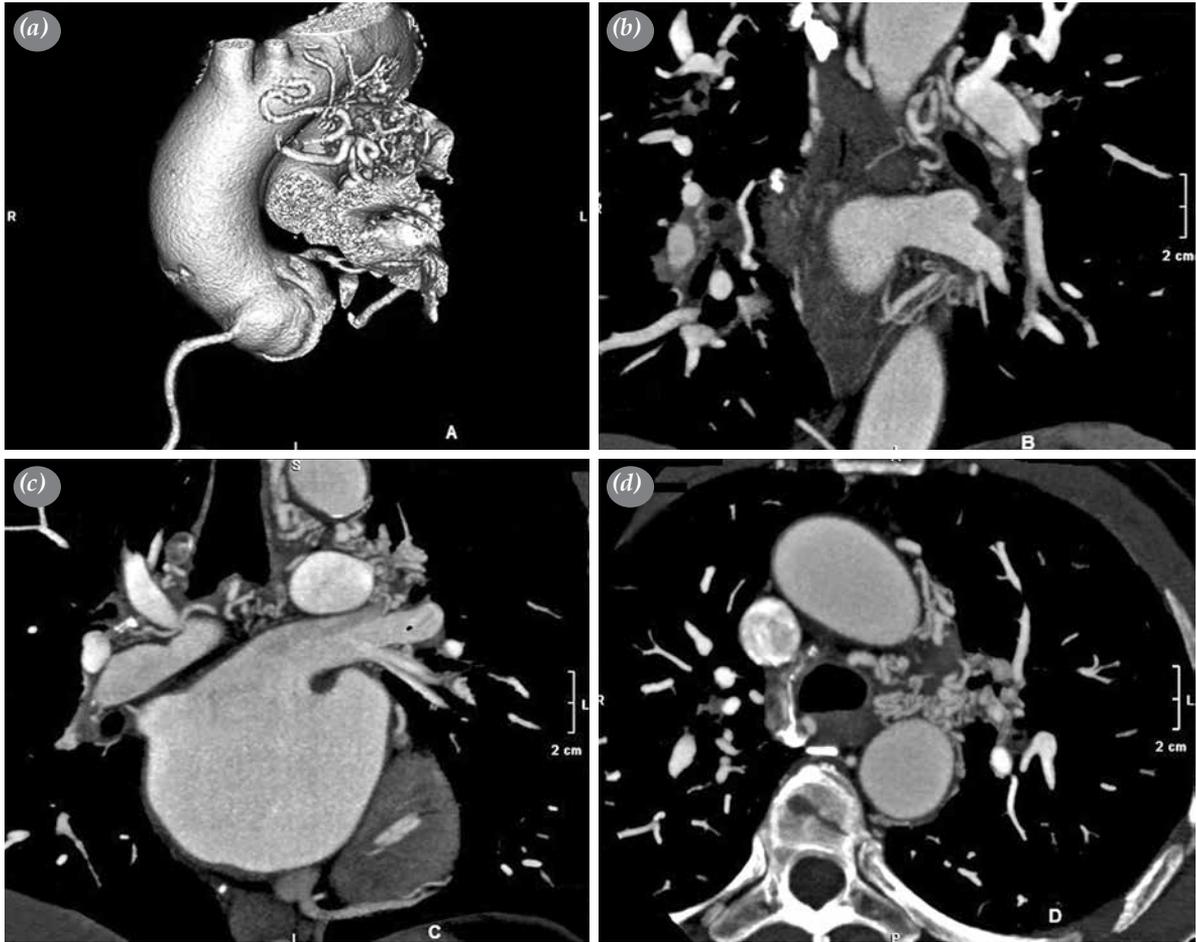


Figure 2. (a) Three dimensional volume rendered, (b, c) coronal and (d) axial maximum intensity projection images of the fistula, anarchic structure in the branches of the bronchial arteries, originating from the distal section of the circumflex artery draining into the superior vena cava.

(2.5%) from the left anterior descending LAD artery proper, and one (2.5%) from the ramus intermedius. One of the conus arteries directly originated from the right coronary sinus. Twelve (30%) of the fistulas were draining into the pulmonary trunk (PT), eight (20%) into the left ventricle (LV), seven (17.5%) into the right ventricle (RV), five (12.5%) into the superior vena cava (SVC), three (7.5%) into the right main pulmonary artery (RPA), two (5%) into the right atrium (RA), one (2.5%) into the left atrium (LA), one (2.5%) into the right internal thoracic (mammary) artery (RIMA), and one (2.5%) into the coronary sinus (Table 1).

In addition, vascular malformations were also detected; in two patients they originated from the bronchial arteries, draining into the superior vena cava (SVC) in one and into the PT in the other; in one patient they originated from the left subclavian artery draining into the PT, in one patient originated

from the RIMA and draining into the LA, while in one patient originating from the pulmonary artery branch feeding the medial segment of the middle lobe of the right lung, and draining into the LA. The all vascular malformations somehow join into the vascular network of coronary fistulas.

DISCUSSION

Coronary artery fistulas are rarely observed congenital anomalies. Case reports are frequently reported in the literature, while the numbers of series reports are few. The largest series was that reported by Yamanaka et al.^[8] for 225 (0.17%) CAF cases of 126.595 patients who underwent coronary angiography. Lim et al.^[9] reported 56 (0.88%) CAF cases in the 6.341 patients who underwent MCTA, while Zhou et al.^[10] reported 33 (0.18%) CAF cases in 17.584 patients. On the other hand, 2.415 patients were investigated in our study

Table 1. Distribution of coronary artery fistulas according to age, gender, origin and area of insertion

Case	Gender/Age	Origin	Insertion
1	F/53	Cx	PT
2	F/43	Cx	RPA
3	F/40	LAD	RV
4	F/71	LAD, Cx, LMCA	PT
5	M/69	LAD	RV
6	M/51	LAD	LV
7	F/51	LAD	RV
8	F/67	Septal 1, 2, 3	RV, LV
9	F/61	LAD proper	PT
		Conus artery	LV
		Diagonal	
10	M/69	LMCA	PT
11	F/43	Diagonal1 (anterior and posterior branch), Diagonal 2	LV
		OM	
12	M/23	Cx	LA
13	F/45	RCA	RA
14	M/67	Cx	RPA
15	M/33	RCA	SVK
		LMCA	
		Cx	
16	F/60	Cx	RPA
17	M/54	Cx	SVK
18	F/59	Conus artery	PT
		LAD	
19	M/57	Cx	RIMA
20	F/54	Ramus intermedius	PT
21	M/55	RCA	PT
		LAD	
22	F/49	LAD	LV
23	M/40	Cx	Coronary sinus
24	M/59	Conus artery	RA
25	M/16	LAD	RV
26	M/48	LAD	RV

Cx: Circumflex artery; LAD: Left anterior descending artery; LMCA: Left main coronary artery; LV: Left ventricle; OM: Obtuse marginal artery; PT: Pulmonary trunk; RA: Right atrium; RCA: Right main coronary artery; RIMA: Right internal mammary artery; RPA: Right main pulmonary artery; RV: Right ventricle; SVC: Superior vena cava.

and CAF was detected in 26 (1.07%) of the patients. This study is the third largest coronary MCTA series reported in the literature.

The incidence of coronary artery fistula has been demonstrated by conventional coronary angiography as 0.05-0.25% in different studies. In our study, the incidence of CAF (1.07%) was found to be higher than that of conventional angiography. Multislice computed tomographic angiography provides high anatomic resolution, minimization of pulsation artefacts, and provides three-dimensional evaluation of conventional angiography, using advanced electrocardiography-triggered (ECG gating) reconstruction methods. In

most studies, the most common origin for coronary artery fistulas has been reported as the right coronary artery and branches with an incidence rate of 55%, whereas in the same studies origin from the left system had a rate of 35%. Canga *et al.*^[11] reported that the most common origin for coronary artery fistulas was the left anterior descending artery (50.8%) and the most common drainage was into the pulmonary trunk (53.7%). On the other hand, results of our study show that the rate of fistulas originating from the right coronary artery and its branches was 17.5%, the rate of fistulas originating from the left anterior descending artery and its branches was 45%, whereas

the rate of those originating from left system was 82.5% (Table 1). In their study Yamanaka et al.^[8] reported a 95% incidence rate of fistulas between the coronary artery and pulmonary artery; however, this rate was found to be 37.5% in our study. In our study, we detected the proper origin of the left anterior descending (LAD) artery, and coronary sinus and right internal mammary artery (RIMA) insertions. These results have not been reported in previous studies, and from the best of our knowledge are the first of such cases in literature.

Most fistulas are thinly calibrated or low-flow and are only found incidentally during coronary angiography. Conventional coronary angiography can safely show the proximal portion of CAF, and can provide information about the prevalence and number of CAFs. However, since CAFs drain into low-pressure chambers of the heart, contrast agents are diluted in these areas and drainage areas may not be well visualized on conventional angiography.^[12] Kadiroğulları et al.^[13] also used coronary MCTA to give a complete view of the coronary anatomy, in their case reports of intercoronary communication and of coronary artery fistulas. Markedly dilated CAFs can also be detected by echocardiography. Magnetic resonance imaging (MRI) and MCTA are noninvasive and useful imaging modalities for the detection of major coronary artery anomalies. The use of multiplanar reforming techniques helps to visualize the origin and insertion of abnormal vessels.^[14] Multislice computerized tomographic angiography provides high anatomic resolution, minimizing pulsation artefacts using ECG-triggered reconstruction methods. Dilated fistulas allow for the evaluation aneurysmal dilatation and the formation of thrombus in the vessels. Aneurysmal dilatation was detected in five (19%) of our patients. Volume-rendered images obtained from three-dimensional CT data sets are helpful in evaluating the anatomy of the heart and vessels, and for demonstration of anatomical details before surgery.^[12]

In conclusion, the prevalence of coronary artery fistula detected by multislice computerized tomographic angiography in our study is higher than that with conventional coronary angiography. Coronary multislice computed tomographic angiography, may be considered as a good alternative to echocardiography and conventional angiography. The superiority of multislice computerized tomographic angiography over conventional coronary angiography is hidden in the determination of the origin and insertion, and in its contribution to treatment planning. In addition to being

a noninvasive method for the detection of coronary artery fistulas, coronary multislice computerized tomographic angiography may be a useful but may also allow for a detailed description of the cardiac anatomy.

Declaration of conflicting interests

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